

Policy Options for Reducing Natural Gas Leaks in Massachusetts

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May, 2014

Masters project submitted in partial fulfillment of the
requirements for the Master of Environmental Management degree in
the Nicholas School of the Environment of
Duke University

2014

Abstract

Massachusetts' natural gas distribution systems – pipes delivering gas for fuel into homes and businesses – are leaking large quantities of gas due to aging and crumbling infrastructure – primarily pipes made of the outdated materials cast iron and unprotected steel. This is problematic in several ways. First, public safety is at risk from explosions and fires from the leaked gas; second, uncombusted methane in natural gas is a more potent global warming gas than carbon dioxide – contributing to climate change; and third, ratepayers bear the cost of the lost gas, as well as the costs of publicly- and privately-owned trees and shrubs that are harmed by soil health damage near the leaks.

This master's project explores actions being taken or considered in Massachusetts and in states with similar gas infrastructure to reduce natural gas leaks, and includes recommendations to achieve further reductions. A comparative case study approach was used to examine Massachusetts, Pennsylvania, New York, and federal policy activity. Methods for the case studies included examination of publicly-available materials as well as interviews with individuals from different areas of expertise or leadership with respect to gas distribution systems.

Findings indicate that there is no single, simple, or inexpensive solution to eliminating gas leaks from old, leak-prone infrastructure, but that a combination of approaches from the multiple states studied may lead to reductions in gas loss if implemented in Massachusetts. Recommendations include: adoption of consistent measurement and reporting criteria for lost gas from all utilities as modeled by Pennsylvania's 2013 regulations revisions; creation or expansion of incentives for utilities to reduce leakage such as New York's innovative benchmark and profit incentive for utilities alongside the federally proposed state revolving loan fund model for capital investments in system upgrade costs; and incorporation of the value of avoided environmental damage into all cost benefit analyses for aging pipeline repair and replacement. Finally, caution is needed in any new regulation or practice adopted to be assured that repair and replacement investments are served, and funding not redirected for additional natural gas capacity, keeping in mind that overreliance on any single fuel could prove a foolish gamble.

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Acknowledgements

I would like to thank Dean Bill Chameides for his guidance and feedback regarding this analysis, as well as helpful introductions to leaders in the field of gas leaks research and advocacy. I would also like to thank Dr. Deb Gallagher for her generous support in helping shape and guide my project.

Dr. John Berg of Suffolk University provided leadership and helpful research assistants from his Environmental Politics and Policy course. Student Team consisted of Nicholas Hutchings, Rahell Nere, Kyle Spencer, Tyler Chaffee, and Michael Ogunjimi.

Finally, thank you to my Clean Water Action family of colleagues, Dr. Nathan Phillips and his generous students Bahareh Sanaiemovahed and Margaret Hendrick, Bob Ackley, Shanna Cleveland, Senator Ed Markey and his diligent staff, Representative Lori Ehrlich, Senator Jamie Eldridge, and activists here in Massachusetts for working hard on strong gas leaks solutions for the Commonwealth, and to the other individuals who took the time to speak with me regarding gas leaks from their agencies, organizations, and states, especially Mr. Nathan Paul in Pennsylvania.

Introduction

There are more than 3,300 natural gas leaks in the City of Boston, and at least 20,000 known leaks throughout Massachusetts, releasing at least 1.7 billion cubic feet of natural gas annually (Phillips et al., 2013; Cleveland, 2012). Massachusetts is losing more natural gas than is being saved through aggressive energy efficiency retrofitting programs throughout the commonwealth, and ratepayers bear the burden of nearly \$40 million of lost and unaccounted for gas each year (Cleveland, 2012). The natural gas leaks are threats to public safety, economic justice, and to greenhouse gas (GHG) reduction strategies for Massachusetts. Current state and federal policies provide disincentives for pipeline owners to aggressively find and fix these leaks (Cleveland, 2012).

A team of researchers from Boston University and Duke University, and led locally by Professor Nathan Phillips and Bob Ackley of Gas Safety USA identified 3,356

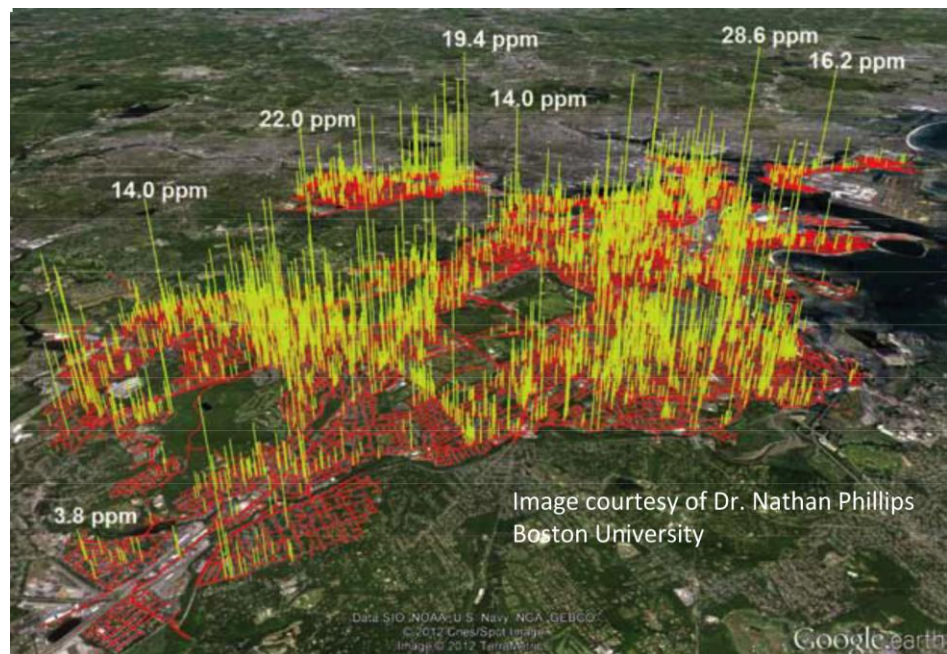
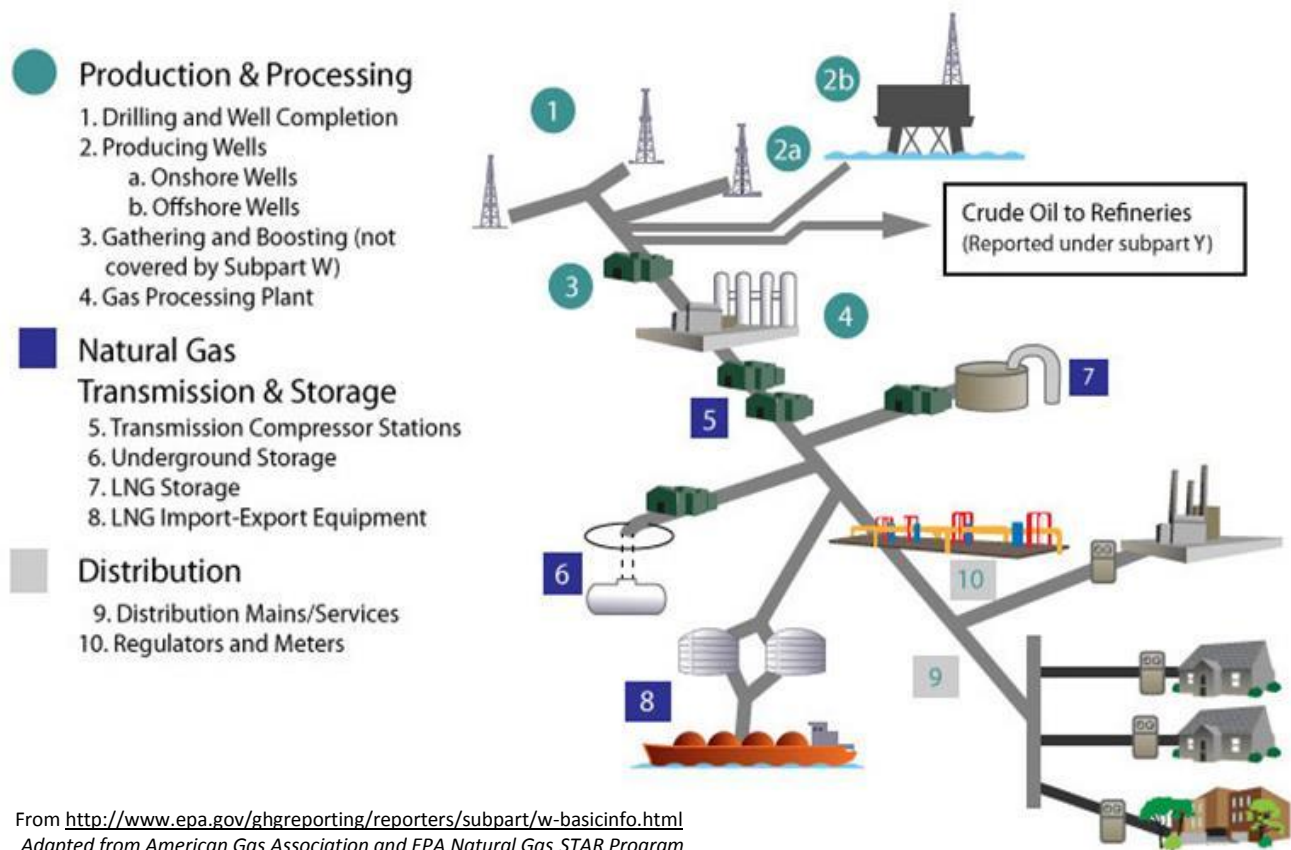


Figure 1. Methane leaks in the city of Boston

methane leaks (Figure 1) that exceeded 2.50 parts per million (ppm), represented above by their corresponding spikes. These levels are well above the city's mode background

concentration of 2.07 ppm, as measured by the team in the course of mapping Boston's 785 road miles (Phillips, 2013).

The leaks were measured using a mobile Picarro G2301 Cavity Ring-Down Spectrometer equipped with an A0491 Mobile Plume Mapping Kit. The leak samples were compared to samples of methane from nearby landfills, wetlands, and the region's centralized wastewater treatment facility, Deer Island, and were found to have a unique enough signature to differentiate the methane from fugitive gas leaks from these other types of sources that might occur in the city (Phillips, 2013). Note that this research is germane to the distribution portion of the infrastructure, as indicated below in Figure 2 under numbers 9 and 10.



From <http://www.epa.gov/ghgreporting/reporters/subpart/w-basicinfo.html>
Adapted from American Gas Association and EPA Natural Gas STAR Program

Figure 2. An illustration of the life cycle of natural gas production, transmission, and distribution

Purpose and Research Questions

This project's purpose was to identify current practice, existing barriers to, and potential for, reducing natural gas leaks in Massachusetts' distribution system; to seek out potential model solutions from other states, regions, or utilities; and to create a set of recommendations for Massachusetts to explore for reducing fugitive gas emissions in order to reduce effects on climate change and ratepayers, and to protect public safety.

Research Questions:

1. What is being done to reduce leaks from Massachusetts' natural gas distribution system?
2. What are other states or utilities doing to address leaking gas from their distribution systems?
3. What are recommended approaches for Massachusetts based on what is being done currently or pursued in other places?

Background

Why are there so many leaks?

Much of Massachusetts' infrastructure systems which provide services such as transportation, water, wastewater, and energy are aging and crumbling, including the state's gas delivery systems. Some of the gas distribution mains are well over 100 years old. In an April, 2011 letter to the U.S. Department of Transportation's Pipeline and Hazardous Materials Safety Administration (PHMSA), the Director for the Massachusetts Department

of Public Utilities (MA DPU) Pipeline Engineering and Safety Division explained that

"The 11 gas distribution operators in the state have over 21,000 miles of gas mains and over 1 million gas service lines in their systems. Nearly one-third of the mains are constructed of cast iron or unprotected steel. Some of the cast iron mains were installed in the 1800s" (Bourne, 2011).

The United States Environmental Protection Agency (US EPA) has identified both cast iron and unprotected steel as the two most "leak prone" of the gas pipeline materials used in distribution systems in the United States.

Main means a distribution line that serves as a common source of supply for more than one service line. **Service Line** means a distribution line that transports gas from a common source of supply to an individual customer, to two adjacent or adjoining residential or small commercial customers, or to multiple residential or small commercial customers served through a meter header or manifold. A service line ends at the outlet of the customer meter or at the connection to a customer's piping, whichever is further downstream, or at the connection to customer piping if there is no meter (PHMSA, Part 192).

“Cast iron was the material of choice for low pressure distribution mains in the U.S. until the 1950s. Pipelines typically consist of 12-foot sections connected by bell and spigot joints, shown in Figure 1 , that are sealed by jute packing plus cement or molten lead. Leaks tend to develop in the packing over time due to heavy overhead traffic, freeze-thaw cycles, naturally shifting soil, and the switch to dryer natural gas” (Bylin, Cassab, Cazarin, Ori, Robinson & Sechler, 2009).

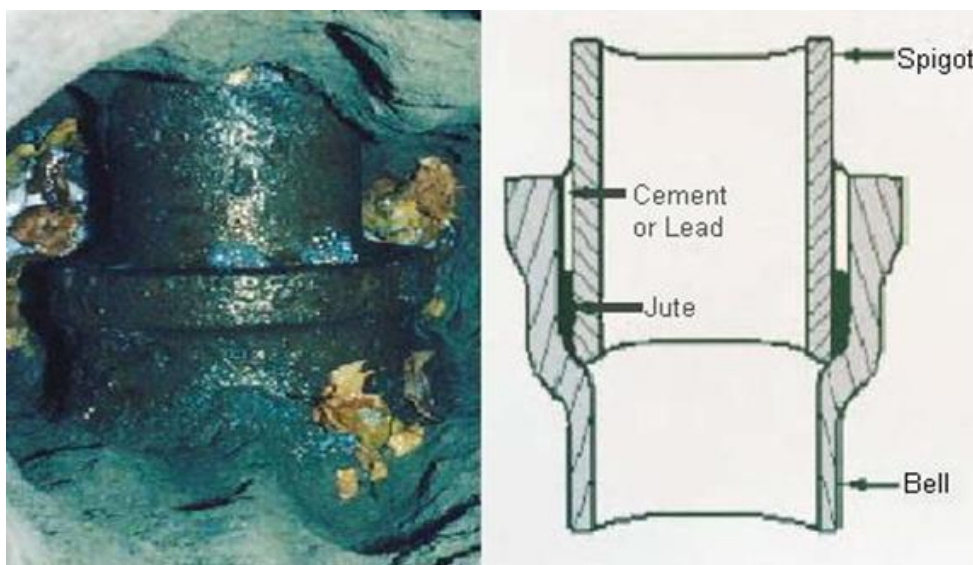


Figure 4. The anatomy of a cast iron main. Image credit Bylin, Cassab, Cazarin, Ori, Robinson & Sechler, 2009

In 2012, revisions to reporting criteria in the EPA’s Mandatory Reporting of Greenhouse Gases Rule specific to Petroleum and Natural Gas Systems included standardized leak rates for gas distribution pipeline materials which all reporting systems must use. These are called “Emissions Factors” and give an estimated leak rate from each type of pipe material in natural gas distribution systems. As shown below, cast iron is the leakiest, and unprotected, or “bare,” steel, is next:

Table 1

Material	EPA's Emissions Factors (standard cubic feet/hour/mile)
Cast Iron	27.5
Unprotected Steel	12.58
Plastic	1.13
Protected Steel	0.35

Data from 40 C.F.R. Part 98, Subpart W, Revision to Petroleum and Natural Gas Systems

A 2009 study that included EPA Gas Pipeline staff called these emissions factors into question, acknowledging that they could be far too conservative in the estimates of how much gas is escaping the cast iron pipes, specifically. The study team compared the results of a Brazilian study began in 2005 which took over 900 samples of leaking gas from cast iron pipes

Table 2

Study	Location	Year	Sample Size	Leak Rate (scf/mile-year)
EPA/GRI	North American	1992	21	428,123
Comgas	Brazil	2005-present (2009 reporting)	912	803,548

to

the 1992 North American study which was based on 21 samples, and on which the EPA continues to rely for estimated emissions factors. The results, displayed below in Table 2, show a large difference in the estimated gas leak rate of nearly double, given in standard cubic foot per mile-year (Bylin et al., 2009):

As these industry- and agency-wide discrepancies show, consistency in measuring, calculating, and reporting fugitive emissions is a concern in determining actual volume lost in all locations with remaining cast iron gas distribution pipes. In a hearing on June 11, 2013, Massachusetts' Secretary for Energy and Environmental Affairs, Rick Sullivan, explained that there is not a consistent accounting or reporting methodology for lost and unaccounted for gas from the distribution system (Sullivan, 2013). One local example of inconsistency in reporting

fugitive emissions from distribution pipelines here in Massachusetts includes 2010 totals reported to the Massachusetts Department of Environmental Protection (MA DEP) versus amounts reported to MA DPU. There is a nearly 3 billion metric ton difference in CO₂ equivalent calculated and reported (Cleveland, 2012).

Further, in the report *America Pays for Gas Leaks* recently commissioned by Senator Ed Markey, “companies frequently report negative volumes of unaccounted for gas to various agencies – even though it’s physically impossible to dispose of more gas than enters a closed system” (2013).

There are multiple negative outcomes when gas escapes from distribution systems. These include, but are not limited to: that potent greenhouse gas methane is released; that ratepayers are charged for the lost “valuable, non-renewable hydrocarbon resource”; that public safety is threatened by explosions and any other public health concerns related to methane exposure or atmospheric increases; and that trees and natural foliage are harmed or killed by the effects on nearby soil chemistry and create added public and private expense to the gas leaks equation (Bylin et al., 2009).

Why Do Leaks Matter?

Climate Natural gas has the reputation of being a “cleaner” fuel than coal and oil. However, US EPA’s analysis confirms that when leaked instead of burned, uncombusted methane – the main ingredient in natural gas – is worse for the climate than CO₂: “Pound for pound, the comparative impact of CH₄ on climate change is over 20 times greater than CO₂ over

a 100-year period” (EPA, 2014; Shindell et al., 2012). According to EPA’s most recent annual National Greenhouse Gas Emissions Data reporting, “Energy-related activities were the primary sources of U.S. anthropogenic greenhouse gas emissions This included 40 percent of the nation's methane (CH₄) emissions” (EPA, 2014).

Even more alarming for the prospects of the short term climate implications of leaked methane is the possibility, suggested by recent projections of the International Panel on Climate Change (IPCC) that in the short term – a 20-year timespan of effects compared to a 100-year timespan in the widely accepted Shindell study – methane could actually be up to 84-87 times more potent a than CO₂ at trapping heat into earth’s atmosphere, and

“When it escapes into the air, during the first year a pound of methane is 120 times more powerful than a pound of carbon dioxide in trapping heat at the earth’s surface. Methane is the biggest contributor to short term climate pollutants that have caused about one-third of the warming that we are currently experiencing, leading to hotter temperatures, droughts, crop loss, and more intense storms” (Methane Reduction, 2014).

Depending upon the size of natural gas leaks over its entire life cycle – during production & processing, transmission & storage, and distribution – the warming from fugitive emission of methane might actually outweigh the climate benefits of shifting reliance to gas away from coal or oil. In short, as stated in 2012 by Alvarez et al., “There is a need for the natural gas industry and science community to help obtain better emissions data and for increased efforts to reduce methane leakage in order to minimize the climate footprint of natural gas” (2012).

Costs Currently, ratepayers in Massachusetts bear the costs of the lost and unaccounted for gas from the distribution system – paying for gas which is never delivered or used in their homes or businesses. This creates a disincentive for utilities to prioritize repairing or replacing pipes which may be leaking but which may not present an immediate explosion risk. Paying for these lost and unaccounted for gas volumes is really only one cost associated with these fugitive emissions. There are also the costs to society from the effects of losing a limited resource, and from climate change, which is exacerbated by the release of uncombusted methane. These less direct and often unrecognized expenses to society go essentially uncalculated while utilities continue to profit from these same consumers.

Ratepayers' direct cost burden in Massachusetts has been significant. In the period 2000-2011, costs that were passed on to ratepayers for unaccounted for gas ranged from \$640 million to \$1.5 billion, according to a 2013 report by U.S. Senator Ed Markey's research staff (America Pays, 2013). Utilities are able to spread their costs of lost product among their ratepayers in the form of fees, such as "Gas delivery charges" included in customer bills. See below from customer bill explanation from National Grid for gas billing to private residential consumers in Boston:

***"Gas delivery charge** - This represents the cost of local transportation of gas to your home or business, providing safety services, local pipeline maintenance, meter reading, billing and payment processing, and other business related costs. Every customer pays a **Minimum Charge** that covers our fixed costs of providing service to you, whether or not you've used gas during the billing period. The **Rate Block Steps** show you how your cost per therm decreases as you use more gas. For many commercial customers, there is only one Rate Step after the Minimum Charge.*

***Gas supply charge** - This charge represents the actual cost of gas purchased by Grid from suppliers and delivered to our service area. The price you pay is the price we pay. We are not allowed to mark up the gas supply charge."*

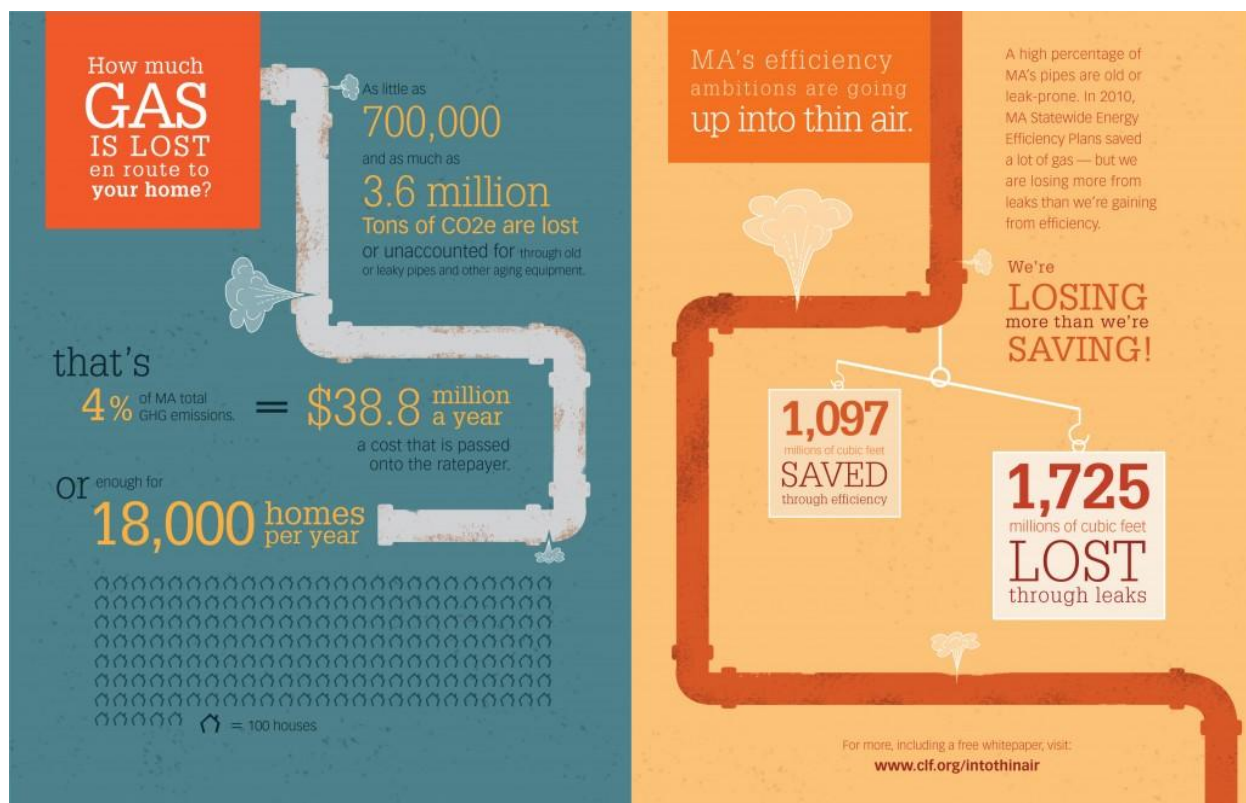


Figure 5. Explanation of Gas Loss from Massachusetts' systems. Infographic courtesy of Conservation Law Foundation

As with any large infrastructure system, such as water or gas pipes, some loss of the resource is to be expected; in this case the question is whether such large leakage rates and concomitant costs to consumers are reasonable. Reasons for expected loss of gas from distribution systems include, but aren't limited to, leakage or other actual loss such as theft, meter inaccuracies, and variations in pressure and temperature (Pennsylvania Public Utility Commission, 2013). "However," as noted by Attorney Shanna Cleveland in her report *Into Thin Air*, "the fact that there may always be some loss on the system should not be used as an excuse for failing to track and correct the causes of loss that can be addressed. Unfortunately, the fact that there is no distinction between cost recovery for gas that is lost through unavoidable means and gas loss that could have been avoided means that companies do not

typically even attempt to quantify whether and how they might reduce their lost and unaccounted for gas volumes” (2012).

In Massachusetts, the 2008 law known as the Global Warming Solutions Act stipulates that the Commonwealth must reduce greenhouse gas emissions by 25% by 2020 and 80% by 2050 over 1990 levels. In pursuit of meeting these mandates, there is a customer charge on every residential and business consumer’s electric or gas bill in Massachusetts which directs customer dollars to a pool of funds to be used for energy efficiency measures in homes and businesses. The funds are spent on providing incentives for home and business energy audits and weatherization retrofitting. This often consists of installing low-energy light bulbs, programmable thermostats, sealing windows and doors, replacement of the most inefficient appliances and insulating entire building exterior walls.

In its current 3-year plan cycle, MA’s energy efficiency program—known as *Mass Save* – has a \$2.25 billion dollar budget, and is ranked as the #1 program in the U.S (American Council for an Energy-Efficient Economy, 2013). In 2010, according to analysis by the Conservation Law Foundation, the statewide natural gas efficiency program saved 1,097 million cubic feet (MMcf) of natural gas. However, the analysis also found that in the same year, MA’s leaky gas distribution pipes lost at least 1,725 MMcf. “We are losing more on the distribution than we are saving [through energy efficiency practices], and customers are still paying for those losses” (Cleveland, 2012). In fact, customers are currently being charged for both – paying into the energy efficiency savings pool *and* paying for the lost gas.

Climate & Costs Meet A 2013 report by the Analysis Group calculated the benefits of several gas utilities’ Targeted Infrastructure Replacement Fund programs (TIRF), including the

three which have been approved by MA DPU and initiated in MA. Their calculations of benefits, “using the most widely accepted assumptions from the EPA for gas leak rates, global warming potential and the social cost of carbon” were based solely on those of the reduced gas supply costs and the lowered GHG emissions’ effects on climate and ensuing cost savings to society when leaks are stopped (Aubuchon & Hibbard, 2013). These benefits are in addition to utilities’ or states’ likely focus on calculating benefits of accelerating repair based on reduced public safety threats from explosions or fires and those associated costs. The Analysis Group’s report results indicate that over the full program life of the current TIRF programs – calculated at a conservative replacement pipe lifetime of 20 years – the accelerated repair programs for old pipe in these three (out of eleven) MA gas providers leads to total 20-year project lifetime net ratepayer benefits of \$156 million (Aubuchon & Hibbard, 2013).

There is a bottom line message to these multiple threads about costs of natural gas leaks: consumers are paying locally, globally, financially, and with the failing health of the planet’s ability to support them.

Public safety Loss of life is the most critical and visible tragedy that occurs when gas leaks explode or catch fire. In recent years, there have been fatalities in many states across the U.S., including those which do not have a spot on the “radar” for high percentages or quantities of the leakiest types of pipe. In U.S. Senator Ed Markey’s 2013 report, *America Pays for Gas Leaks*, he uses data collected and reported by PHMSA to paint this grim, nationwide picture:

“From 2002 to 2012, almost 800 significant incidents on gas distribution pipelines, including several hundred explosions, killed 116 people, injured 465 others, and caused more than \$800 million in property damage” (2013).



Figure 6. A badly damaged building at 1646 Park Ave. in East Harlem was demolished after a devastating gas explosion March 12, 2014. From ANTHONY DELMUNDO/NEW YORK DAILY NEWS . [Further image credit.](#)

Since deregulation of the U.S. energy market in 1998, “the number of permanent [gas] company employees has dropped by approximately 25%...while the number of customers per employee has risen to nearly double in the same time frame from 350 to 700” (New England Gas Workers Association, 2010). That association makes the case that maintenance is what is largely failing our public safety in energy infrastructure hazards across states and regions. NEGWA suggests that replacing all pipes – cast iron, bare steel, or otherwise – would simply start a ticking clock over again on the lifetime of materials, and that increasing feet on the ground for inspections and maintenance is what can keep the public safest immediately and in the future. Their research presents and compares the number of pipeline inspectors per miles

of gas mains per state and per number of gas services per state, suggesting a correlation in incidents and lack of inspection capacity. Pennsylvania is in the worst position, with nearly 8,000 miles of mains per inspector and over 450,000 services per inspector.

Tree health & associated costs There is sufficient evidence of damage and destruction to trees near gas leaks that gas utilities are recognizing responsibility and paying for replacement in some instances. Nathan Phillips, the Boston University Professor who's partnered with Duke University's Robert Jackson and others to map leaks across Boston and other urban areas, is a plant physiologist, and:

"Phillips notes that...he does believe, as a plant physiologist, that the methane is harming trees. 'Natural gas is largely methane,' Phillips says. 'That displaces the oxygen. It's also dry gas, so it desiccates the soils as well. And roots need to have oxygen for the metabolism of the roots, for repair of the root membranes. If they are starved of oxygen, the tree will suffer'" (Joyce, 2011).



A 1972 study out of the Netherlands detailed an experiment applying methane to healthy tree soils. The scientists determined that the cause of plant damage or death was indirect, meaning: the methane didn't harm the plants or roots, but rather the massive oxygen consumption by methane oxidation and the displacement of the normal air mix

Figure 7. Dying tree damaged by nearby leak. Photo credit: Bob Ackley, Gas Safety, Inc.

within the soil from the dry methane gas did the harm (Hoeks, 1972).

Not only does damage to trees on private and public property create an expense, there are valuable, if less quantified, services that trees perform which are lost when trees are unhealthy or are killed. For instance, trees have capacity to filter air and stormwater and to provide shade cover in otherwise urban heat-islands of pavement. This makes having healthy trees especially important in urban landscapes, where trees are generally fewer, and where there are the greatest frequency of gas leaks.

Methods & Materials

Comparative case study

While natural gas generates up to 25% of consumer energy nationwide, in some states this percentage is significantly higher (Phmsa.dot.gov, n.d.). In Massachusetts and New York, for instance, natural gas makes up 63% and over 37%, respectively, of the consumer electric energy mix (Eia.gov, 2014). Cast iron gas pipes have been in use since the 1830's in the U.S., and while only 3% of the nation's current gas main lines are cast iron, half of those remain in Massachusetts, New York, New Jersey, and Pennsylvania (United States Department of Transportation Pipeline and Hazardous Materials Administration, n.d.).

This information taken together – that a handful of states that rely on natural gas for much of their consumer energy provisions also maintain the vast majority of the oldest, most leak-prone infrastructure to support those provisions – underscores the need for attention to these systems. The fugitive gas emissions and lost and unaccounted for gas, with the companion concerns of public safety, costs for consumers, and environmental damage are concentrated in these states, are not representative of the U.S., and are in fact more urgent. Therefore, this Master's Project has examined the regional issue with respect to failing natural gas distribution infrastructure and requisite policies with the intention of elevating best practices and providing recommendations for Massachusetts' to achieve speedier remediation and, secondarily, preventing further global greenhouse gas emissions effects related to fugitive methane emissions.

Evaluation criteria

Evaluation criteria used to examine conditions and activities around natural gas infrastructure in MA, NY, PA, and at the federal level in this research included: miles and/or percentage of cast iron and bare steel distribution pipes remaining in systems; methods used for determining gas lost on these systems; ways in which ratepayers may be affected by the lost gas; and what each of the states, utilities, or the federal government have undertaken, or are considering or currently pursuing, to remediate these system vulnerabilities.

Materials

Materials for the case studies included examination of publicly-available materials such as policies and regulations, pipeline survey statistics, agency investigations, reports by public and private entities, and legislative testimony, as well as interviews of individuals – both on the record and anonymous – from different areas of expertise or leadership with respect to gas distribution systems.

Addressing leaking gas distribution infrastructure is a current and ongoing topic; is in the public spotlight especially upon occasions of disaster and tragedy such as happened on March 13, 2014 in New York City; and also carries implications for the future of expansion of domestic production, transmission, and distribution. For these reasons, I believe, conducting interviews with public figures was problematic. Individuals were sometimes willing to speak with me on the basis of anonymity, or only if I agreed that their comments would not be used to represent their organizations or agencies, but be considered only “background” information. This, and the fact that I had to disclose the interviewees that I am an environmental advocate for an organization in Massachusetts known for policy, grassroots, and electoral advocacy may have affected the responses I received to my questions.

Table 3 is a representation of the combination of resources I was able to employ for each of the selected case studies:

Table 3

State/Region	Public Documents	On-record Interviews	Off-record or anonymous interviews
Massachusetts	X	X	X
Pennsylvania	X	X	
New York	X		
Federal	X	X	

Below is a list of interviews I was able to obtain in gathering data. One limitation of the data collection is that this method got me the furthest in MA, where my own and my organizational relationships helped with obtaining access to individuals.

- Senior Massachusetts Energy Official, Anonymous
- State Representative Lori Ehrlich
- President of Gas Safety Inc., Robert (Bob) Ackley
- President of New England Gas Workers Association, Mark McDonald
- Off record state agency
- Off record state agency
- Senator Markey (Senior Policy Advisor, Morgan Gray)
- Chief Scientist, Environmental Defense Fund, Steve Hamburg
- Associate, Analysis Group, Inc., Craig Aubuchon
- Management Efficiency Review Supervisor, Pennsylvania Public Utilities Commission, Nathan Paul

Results & Observations

Massachusetts

In 2013, 63% of Massachusetts' electricity was generated by natural gas, and approximately 48.5% of homes in Massachusetts were heated with natural gas (EIA, 2014). This fuel is distributed through a system which consists of 21,285 miles of pipeline and over 1.2 million services, which are the short lines into buildings from the mains, according to 2012 data collected and distributed by PHMSA (2014). Of these thousands of lines of miles and million-plus service lines, 2011 data provided by Massachusetts Department of Public Utilities (DPU) Director of Pipeline Engineering and Safety Division conveyed that 3,990 miles of pipe were made of cast iron, and 3,080 miles were of unprotected steel (Bourne, 2011).

Unfortunately, Massachusetts has had its share of devastating gas leak explosions in recent years, which have brought both public and regulatory attention to the issue of compromised system components as elsewhere in the U.S. Below is a table outlining all incidents, 2004-2013, relegated to natural gas leaks on the distribution system in Massachusetts. Figures on paper don't exactly do justice to the personal narratives of these kinds of incidents. In June, 2013 testimony in support of a bill before the MA Legislature's Committee on Telecommunications, Utilities, and Energy regarding gas leaks repair, retired Police Officer Wayne Sargent described how he'd called and had crews to his home in Gloucester, MA, at least three times based on smelling gas leaking. After working the overnight shift, Mr. Sargent returned home on a January morning in 2009, checked his basement when he smelled gas once more, and had his entire house explode and destroyed. While his injuries

were critical, he survived. His dog, of whom he brought pictures to the hearing, was killed, Massachusetts though that's not represented in the fatalities shown below, of course (Sargent, 2013).

Table 4 Gas Distribution: 2004-2013					
Year	Number	Fatalities	Injuries	Property Damage	
2004	1	0	0	\$182,230	
2005	4	1	1	\$1,688,467	
2006	1	0	1	\$22,005	
2007	4	0	3	\$2,338,989	
2008	1	0	0	\$163,386	
2009	3	1	1	\$794,813	
2010	4	0	1	\$797,578	
2011	1	0	0	\$106,289	
2012	6	1	17	\$2,479,788	
2013	4	0	0	\$954,601	
Totals	29	3	24	\$9,528,149	
2014 YTD	1	0	0	\$9,823	
3 Year Average (2011-2013)	4	0	6	\$1,180,226	
5 Year Average (2009-2013)	4	0	4	\$1,026,614	
10 Year Average (2004-2013)	3	0	2	\$952,815	
20 Year Average (1994-2013)	3	0	2	\$952,815	
Table extracted from: http://primis.phmsa.dot.gov/comm/reports/safety/MA_detail1.html					

The following section provides descriptions, with outcomes when available, of efforts ongoing in Massachusetts to reduce fugitive emissions from leaking gas distribution components.

Targeted Infrastructure Replacement Factor Programs

Three utilities in MA have already initiated programs to accelerate their repair and replacement of cast iron and bare steel pipes with alterations that allow rate increases to cover

their costs ahead of the expenditures. These arrangements are a departure from the usual order of operations, in which a utility would spend money up front for repairs, and not be able to recover those costs until the next rate case period. Without these creative arrangements requested of and agreed upon by MA DPU, the utility typically would be forced to carry the financial burden for accelerated pipeline repair over time, including interest on loans, which creates a disincentive for the repair of these risky, leak-prone pipes. Known in MA as *Targeted Infrastructure Replacement Factor* programs, or TIRFs, this financing program appears, anecdotally, to be accelerating line replacement.

Bay State Gas, National Grid, and New England Gas Company collectively replaced just over 145 miles of leak-prone miles in 2009 as reported by Aubuchon & Hibbard (2013). According to these researchers from Analysis Group, Inc., the additional funds required to make these line replacements totaled approximately \$9.1 million, which the utilities were able to charge ratepayers for up front. Below in Table 5 are calculations based on these repairs, expenditures, and avoided gas leaks reported by Aubuchon and Hibbard:

Table 5

Local Distribution Company	Miles replaced/ total (% replaced)	Cost	Avg cost/mile	Avoided mcf	Avg cost/ avoided mcf
Bay State dba Columbia	20/1166 (1.71%)	\$2,172,698	\$108,635	24,391	\$89.08/mcf
Boston Gas (National Grid)	109.6/3637 (3.01%)	\$6,140,599	\$56,027	109,776	\$55.94
Colonial Gas (National Grid)	9.4/205 (4.59%)	\$251,679	\$26,744	17,231	\$14.61
New England Gas	6.7/278 (2.41%)	\$528,729	\$78,915	11,946	\$44.26

Using the above figures and the range of costs per mile of replacement represented across these three of MA's eleven local distribution companies (LDC's), rough estimates of the cost to replace all remaining miles of cast iron and bare steel pipeline in MA range from about \$176.5 to \$717 million; i.e.:

Using MA DPU 2013 data of approximately 6,600 miles of cast iron and bare steel remaining in MA (reduced from 2011's 7070 miles):

Low range of total replacement costs: 6,600 miles x \$26,744 = \$176,510,400

High range of total replacement costs: 6,600 x \$108,635 = \$716,991,000

In an interview, the researcher pointed out that these costs are likely a lower bound estimate based on the likelihood of expense of replacement increasing incrementally as more and more pipe is replaced (Aubuchon).

Legislation

Massachusetts Senate Bill 2073 originated as House Bill 3873 authored by State Representative Lori Ehrlich, who represents the 8th Essex district on MA's North Shore. The bill passed through the House and was moved into Senate Ways and Means, chaired by Senator Stephen Brewer, where the Committee accepted 24 proposed amendments and went to the Senate floor for debate and vote on April 10, 2014. Approximately one-half of the amendments were engrossed to the bill, which passed the Senate unanimously in a 38-0 vote. The two versions of the bill (House and Senate) have been assigned to a Conference Committee made of several Representatives and Senators whose task will be to hash out the differences and return

to the Senate for a new vote on the revised package. (Please see Senate bill 2073 in Appendix

C.) Provisions in the current Senate version of the bill include:

- Development of a uniform calculation and definition for grades¹ of gas leaks, such that:
 - “Grade 1. A leak that represents an existing or probable hazard to person or property;
 - Grade 2. A leak that is recognized as non-hazardous to persons or property at the time of detection, but justifies scheduled repair based on probably future hazard;
 - Grade 3. A leak that is recognized as non-hazardous to person or property at the time of detection and can be reasonably expected to remain non-hazardous.”
- A standard timeline for response, continuous monitoring, and mandated timeline for repair of each of the grades of leak, such that:
 - “Grade 1 leaks require repair and continuous action until the conditions are no longer hazardous;
 - Grade 2 leaks shall be repaired or cleared within 12 months from the date the leak was classified;
 - Grade 3 leaks shall be reevaluated during the next scheduled survey , or within 12 months from the date 1st evaluated, whichever occurs first, until the leak is eliminated or the main is replaced.
- Required gas pipe inspection beneath any roadway opened for other projects in order to make simultaneous repairs;
- Elevation of leaks detected within school zones, adjacent to houses of worship, healthcare and aging care facilities, correctional facilities, rail or subway station, courthouse or government office to expedite repair schedule;
- Required annual reporting of all leaks detected (grades 1, 2, and 3) and reports of follow up activities by each utility” (Massachusetts General Court, Senate Ways and Means Committee, 2014).

Massachusetts Department of Public Utilities Ongoing Study: Quantifying Lost & Unaccounted for Gas

¹ Currently, leaks are “graded” by the utilities based on their likelihood to pose immediate danger or threat of explosion. There is no federal or statewide standard set for classifying leaks, and utilities are only required to repair “hazardous leaks” according to federal guidelines.

Massachusetts DPU is ultimately responsible for the regulation of natural gas and its infrastructure throughout the Commonwealth of MA. It should be noted that, under this arrangement, the proposed legislation at the Massachusetts State House, discussed in detail above, is prescribing regulations that would be proposed, promulgated, carried out, and enforced by the DPU.

Recognizing that MA has a high percentage of leak prone gas distribution infrastructure, a representative from MA Executive Office of Energy and Environmental Affairs stated that, “In July 2013, the DPU hired an independent, third-party consultant to quantify the amount of gas that is lost and unaccounted for in order to review and identify methods and procedures to reduce methane emissions” (Buckley, 2013). This study is currently underway, and is expected to be released in August, 2014. The goals, summarized below, are to review the reporting requirements from the eleven LDC’s regarding lost and unaccounted for gas to decide if they are adequate as they stand for evolving reporting needs. A summary of the MA DPU study is included as Appendix E.

From the publicly-available *Request for Quotes* distributed at the study’s commissioning, specific tasks for the report may include:

- “Conducting a mass balance analysis of the fate of gas entering Massachusetts gas distribution systems in a recent year;
- Recommending methods to increase the accuracy of the reporting of methane emissions from the natural gas infrastructure by the local gas distribution companies;
- Identifying a reliable method for calculating the amount of lost and unaccounted for natural gas that escapes from distribution pipelines;
- Recommending policies to promote the reduction of methane emissions and reduce the costs of lost and unaccounted for gas;

- Identifying and preparing preliminary recommendations for possible changes in the manner in which the DPU obtains information from LDCs;
- Identifying and preparing preliminary recommendations for possible changes in reporting practices and procedures” (Massachusetts Department of Public Utilities, 2013).

Trees

As detailed above, there is sufficient evidence that methane leaks are affecting soil and tree health, and that correcting this damage should be considered in recommendations for gas leaks remediation moving forward.

Here in Massachusetts, Bob Ackley is a teammate of Boston University’s Nathan Phillips’ on urban leaks research, and a 25+ year veteran of detecting leaks for multiple utilities before heading out on his own to form Gas Safety, Inc. Ackley is also a leader of the Massachusetts Public Shade Tree Trust. He has done extensive leak detection work in communities across the Commonwealth, and believes there is proof that fugitive methane emissions are causing up to \$15 million or even \$25 million in damages to trees across Massachusetts (Ackley, 2014).

Regarding a pending \$1 million law suit against local gas distribution company National Grid by one community – Brookline, MA – over costs of tree damage and death, spokesman for the company, David Graves, claims that there is not evidence to support allegations of such widespread damage to trees from gas leaks. However, Graves notes that, “We work with communities on individual cases where they believe gas may have damaged a tree,” he says. “If we can prove gas is responsible, we replace the tree at our cost” (Barlow, 2011).

There is legislation filed at the state level in Massachusetts that would require LDCs to pay back any owner, including private residents and municipalities, for trees damaged or killed by gas leaking from their pipes. State Representative Lori Ehrlich's Bill is *House Bill 2934 An Act to Prevent Unnecessary Arboreal Costs Due to Natural Gas Leaks*. This bill has not enjoyed the same level of success as the broader gas leaks bill outlined above, but did garner the support of a dozen House Members as co-sponsors and had a hearing in June, 2013 before being sent off to "study" at the Legislature (Ehrlich, 2013).

Pennsylvania

Natural gas heats more homes in Pennsylvania – 38% – than any other fuel, and in 2012, there were approximately 3,000 miles of remaining cast iron natural gas distribution pipes across the Commonwealth ('Pennsylvania State Energy Profile and Estimates', 2014;



Figure 8. A fatal 2011 gas leak explosion in Philadelphia, PA (Maykuth, 2013)

Pennsylvania Public Utility Commission, 2012). Unfortunately, there have also been gas leaks disasters with multiple fatalities in recent years in Pennsylvania. For instance, a January, 2011 leak and explosion (Figure 8) in Philadelphia killed one utility worker, leveled a rowhouse in the Tacony neighborhood, and injured five other people (Maykuth, 2013). Pictured above, just a

month later in February of 2011, a massive gas explosion in Allentown flattened two rowhomes and burned an entire block, killing five people ('5 Dead after Massive PA Gas Blast', 2011).

Additionally, a precedent-setting enforcement action regarding a leaking pipe was brought against Pennsylvania gas company, UGI Penn Natural Gas Inc., in August, 2013. The enforcement bureau of the PA Public Utility Commission settled the largest fine against a utility in PA -- \$1 million – for failing to repair a high-pressure, “10-inch-diameter gas main in a busy commercial area in Wilkes-Barre that was leaking dangerously” (Maykuth, 2013).

In the course of these events, the PA PUC had recognized that across their multiple Natural Gas Distribution Companies (NGDC’s) there was inconsistency in calculating and reporting unaccounted-for-gas levels (UFG):

“Unfortunately, the large deviation illustrates that the Commission is not receiving accurate, meaningful, or consistent calculations of UFG levels. In addition, four companies (Columbia, NFG, UGI Utilities, and UGI – Penn Natural) have reported negative UFG in Annual Reports or 1307(f) Filings. A negative UFG percentage indicates a flaw in the measurement, calculation or definition of UFG” (Pennsylvania Public Utility Commission, 2012).

This led to PA’s Public Utilities Commission (PUC) developing a joint research team from their Bureaus of Investigation & Enforcement and Audits to evaluate the impact that the UFG was having on ratepayers. The report *Unaccounted for Gas in the Commonwealth of Pennsylvania: Joint Report by the Bureau of Investigation and Enforcement and the Bureau of Audits* led to the general conclusions that the PUC “should consider establishing a clear definition of UFG to eliminate any inconsistencies...[and]... consider establishing specific metrics to establish and transition to an acceptable level of UFG” (Pennsylvania Public Utility Commission, 2012).

The results of the report facilitated the formation of yet another team from across multiple bureaus (Law, Office of Special Assistants, Audits, and Technical Utility Services) to explore the creation of new regulations for UFG. What followed, according to PUC Management Efficiency Review Supervisor Nathan Paul, was a full rulemaking process with public comment and response period, a trip for the proposed regulations through PA's legislative House, and establishment of a Final Rulemaking Order and new regulations (Paul, 2014). Following is a summary of the new regulations in PA, adopted April 4, 2013:

- The PUC used 66 Pa.C.S. Section 1301 which includes the duty to “ensure that rates remain just and reasonable” to “establish a rebuttable presumption that levels of UFG above certain threshold levels are not just and reasonable expenses and, therefore, not recoverable from consumers.”
- The rulemaking and regulations define UFG, establishes the uniform terminology use of UFG and provides for a standardized calculation worksheet for UFG. The brief, 3-page regulations package also contains a metric for distribution system losses which lowers each year what percentage of UFG can be recovered from ratepayers. This begins with a cap at 5% and lowers by one-half percentage point each year to rest at 3% unless a NGDC can provide satisfactory evidence to the PUC to allow cost recovery for UFG at a higher percentage (Pennsylvania Public Utility Commission, 2013).

Explanation for the need for new regulations was provided for in the pre-amble to the regulation:

“Until now, PUC regulations lacked a uniform definition for UFG. Prior to our establishing a uniform definition of UFG here, each NGDC defined UFG based upon individual company experience. This practice has created inconsistencies that hindered our ability to monitor UFG levels across NGDCs, and to gauge with accuracy the corresponding financial burden UFG imposed on all classes of ratepayers” (Pennsylvania Public Utility Commission, 2013).

New York

New York State has approximately 47,880 miles of natural gas distribution pipeline and over three million service lines running into residence or business buildings. Of these gas distribution lines, approximately 6,515 miles remain of bare steel, and 4,254 miles of cast or wrought iron mains, which means that nearly 22.5% of the distribution mains are considered “leak-prone” by US EPA (Pipeline & Hazardous Materials Safety Administration, 2014). More than half of New York homes are heated by natural gas, which is in keeping with national statistics, though NY uses more natural gas to supply household electricity (37.1%) than the national average of approximately 26% (U.S. Energy Information Administration, 2014).

As mentioned, New York has been in the news for a recent tragedy related to natural gas leak incidents: On March 12 of this year – 2014 – there was a devastating explosion in Harlem caused by a 127-year-old leaking cast iron gas pipe. Two buildings were leveled, 8 people lost their lives, and nearly 50 more were injured. Table 6 lists and provides relevant data on the significant incidences in NY’s gas distribution system as reported by US DOT Pipeline and Hazardous Materials Safety Administration since 2004. The report does not appear to capture the very recent (March, 2014) incident. Perhaps this is due to ongoing inspection or investigation of the suspect lengths of pipeline. (Pipeline & Hazardous Materials Safety Administration, 2014).

New York Gas Distribution: 2004-2013				
Year	Number	Fatalities	Injuries	Property Damage
2004	8	2	3	\$5,207,940
2005	3	0	5	\$1,825,743
2006	7	0	2	\$1,018,737
2007	3	1	1	\$363,330
2008	5	1	3	\$3,693,515
2009	6	1	2	\$1,202,603
2010	8	0	2	\$635,568
2011	18	1	4	\$668,398
2012	17	0	8	\$8,855,009
2013	18	0	12	\$3,087,970
Totals	93	6	42	\$26,558,817
2014 YTD	1	0	3	\$142,904
3 Year Average (2011-2013)	18	0	8	\$4,203,793
5 Year Average (2009-2013)	13	0	6	\$2,889,910
10 Year Average (2004-2013)	9	1	4	\$2,655,882
20 Year Average (1994-2013)	9	1	4	\$2,655,882
Table extracted from: http://primis.phmsa.dot.gov/comm/reports/safety/NY_detail1.html Report generated on: 04/02/14				

Table 6

Again, while these are perhaps the most visible consequences of failures of infrastructure and leaks in pipes, they are but one of several. NY's regulating agencies have long been pursuing the reductions of fugitive gas emissions and, according to the 2012 Conservation Law

Foundation report *Into Thin Air*:

"New York is one of the only states that have attempted to tackle this issue through adjustments to the way companies are compensated for [lost and unaccounted for gas] LAUF. The New York Public Service Commission actually establishes an allowed LAUF benchmark during an LDC's rate case and allows the LDC to recover an incentive for its shareholders if it achieves a lower LAUF than allowed or a penalty that is returned to ratepayers if the company exceeds the allowed LAUF" (Cleveland, 2012).

This differs from the approach of the new regulations in Pennsylvania, which sets a percentage cap for which all LDC's are able to recover costs from ratepayers. By allowing for a higher cost recovery percentage from some LDC's than others, the NY law likely creates a stronger performance incentive than the percentage approach adopted by PA. It also provides relief to ratepayers who are burdened by overly large fees for LAUF. In fact, the NY program has resulted in an aggregate net refund of approximately \$12 million to NY ratepayers in 2012 (State of New York Department of Public Service, 2012).

The 2013 *Staff White Paper on Lost and Unaccounted for (LAUF) Gas*, by the New York State Department of Public Service addressed the issue of standardization of measurements of LAUF by LDCs. The report noted that utilities use a variety of different methods to calculate LAUF, which limits the "ability to compare (the LAUFs of) LDC's" because of the many different adjustment factors which go into their LAUF calculations (State of New York Department of Public Service, 2013). The report goes on to state that "The amount of gas metered into the system and out of the system, based on actual meter reads with the annual reconciliation period, should be how LAUF is determined.... Basing the LAUF incentive on total metered in and total metered out is the correct approach."

Federal

While the amount of pipeline materials which EPA-identifies as most leak-prone remains disproportionally in a handful of states, there has been growing attention to pipeline safety at the national level in recent years. This is likely due to the very tragic and shocking nature of explosions and fires caused nationwide when there are accidents; to the fact that there are

many causes of leaks and explosions and can happen anywhere that gas and other combustible fuels are processed, transported, held, or distributed; and because all of the nation's infrastructure ages faster than its components are replaced.

In addition to the nationwide incidents outlined earlier, Senator Ed Markey's report details that American consumers paid at least \$20 billion from 2000-2011 for lost gas that was never delivered or used by ratepayers (2013).

The federal government has stepped up activities in the last several years around gas pipeline safety and education, punctuated by U.S. Department of Transportation Secretary Ray LaHood's "Call to Action" in 2011. The requested action was to conduct reviews of gas distribution pipeline systems, identify high risk pipelines, and rank the most critical pipes as priorities for repair (U.S. Department of Transportation Office of Public Affairs, 2011).

Adding to tools from the federal government toolbox for gas distribution system remediation, Senator Ed Markey has also put forward two pieces of legislation:

"The first bill -- the Pipeline Modernization and Consumer Protection Act of 2013 - would accelerate the repair, rehabilitation, and replacement of natural gas distribution pipelines that are leaking or pose high risks of leaking due to their age, material, or condition. To expedite these upgrades, the bill requires utilities and state regulators to consider adopting policies that prioritize repair timelines to address the leakiest pipes first; cost recovery programs that allow companies to more quickly recover the capital they spend to replace pipelines; and limits on the amount of lost and unaccounted for gas for which utilities can charge consumers.

The second piece of legislation - the Pipeline Revolving Fund and Job Creation Act -- would establish a state revolving loan fund for natural gas pipeline repair and replacement to provide additional tools to states and utilities to address old, leaking pipeline infrastructure. This pipeline revolving fund is modeled on the extremely successful and popular Drinking Water and Clean Water State

Revolving Funds. States would identify natural gas pipeline projects and, as with the established state revolving funds, would have to match 20 percent of the federal funds they receive under this program” (Office of Senator Edward Markey, 2014).

According to an interview with Senior Policy Advisor, Morgan Gray, who contributed heavily to Senator Markey’s 2013 report, the Senator is especially pleased with the multi-sector support for his two recent bills working to fix gas leaks (Gray, 2014). A sample list of supporters includes:

Professional Fire Fighters of Massachusetts, Pipeline Safety Trust, United Steelworkers, National Grid, BlueGreen Alliance, Conservation Law Foundation, Consumer Federation of America, Consumers Union, Clean Water Action, New England Gas Workers Association, Gas Safety USA, Natural Resources Defense Council, United Association of Plumbers and Pipefitters, Massachusetts Chapter Sierra Club, American Public Gas Association, and Third Way.

When posed the question about overlap of funding solutions with his State Revolving Fund loan (SRF) proposal and his urging of support for accelerated repair funding up front for utilities via their ratemaking authorities, Markey’s senior staff member explained why both are necessary: Some utilities may be enjoying a generous rate from their consumers, and may not be willing to open that up for examination before their regulators. Therefore, the prospect of a low-interest loan for capital investments in their systems may create the impetus those systems would need for accelerating system remediation.

Discussion, Recommendations, & Conclusion

Discussion

Neither of the individual states' approaches for reducing lost and unaccounted for gas or gas distribution system disrepair studied here are not identical, nor are they the same as federal approaches being considered. However, there are commonalities which are valuable to note, as well as at least one commonly under-addressed concern. First, Massachusetts, Pennsylvania, New York, and even the federally proposed policy seek to assign a more unified definition and calculation for *leaked gas* as a subset of *lost gas*. By this, they recognize that reportable levels of gas lost from a distribution system have many causes, and that quantities actually lost to leaks is but one. Others include theft, meter errors, venting for maintenance purposes, company use which may not be metered, etc. Greater specificity about the quantity of gas physically leaking out of old or failed pipes can lead to greater accountability for safety, repairs, and costs. The Massachusetts' DPU study, currently underway, represents progress in the direction that both Pennsylvania and New York have made inasmuch as initiating consideration of greater standardization for quantifying fugitive gas emissions from the distribution infrastructure. Following their studies, the recommendations in NY and PA took divergent paths, and Massachusetts' eventual set of proposed remediation strategies could look quite different than either of those, as well.

The under-addressed concern is regarding sheer volume of leaked gas from these distribution systems. While standardizing characterizations of leaks such as in MA's proposed

legislation may add consistency to utility performance and reporting, it may not accomplish reductions in the potent greenhouse gas effects of large volumes of leaked gas.

While the costs to ratepayers and the risk of catastrophic explosions already justify spending to fix leaking distribution pipes in natural gas systems, as state and federal governments both define and adopt into mainstream calculations the benefits of climate change mitigation and adaptation practices, the cost-benefit ratio and thus the demand for more and more drastic action will certainly increase.

However, caution must be taken to protect current ratepayers from bearing the costs of system expansion for new gas customers in the name of 'system maintenance.' Similarly, caution must be taken for any considered expansion of distribution systems for the reasons of overreliance on a single fuel as well as the possibility of delivering more and more product into one end of a pipe, only to be leaking it out as fast along its route. There should be more urgency and use of technology to fix not only leaks that pose immediate public safety threats, but also those which are often characterized as "low risk" or "low grade," but which may be the greatest volume-losers over time.

Recommendations

Principles for an effective program to reduce gas leaks from distribution systems as part of lost and unaccounted for gas must recognize that some loss is inevitable while also creating parameters and incentives for utilities to be responsible for knowledge of leaks on their systems and accountable to their ratepayers for reducing the product loss. Additionally, volume of the leaked gas can no longer be ignored, no matter the explosion threat or lack thereof,

given emergent science on its potency as a greenhouse gas. Next, cost benefit analyses of pipeline replacement which seamlessly integrates the additional benefits of reduced environmental impacts (social cost of carbon, for instance) and savings of a non-renewable fossil fuel must adopted into ALL calculations. Finally, careful provisions must direct dollars from ratepayers and other sources which are intended for system repair and upkeep away from use for system expansion.

Recommendations from other states' practices and the proposed federal activities that can help a program in Massachusetts achieve these principles could include a standard definition and calculation of unaccounted-for-gas which provides for transparent adjustment factors and rates that might be modeled after Pennsylvania's 2013 regulations revisions; an incentive program for increased capture of gas in the distribution system such as New York's which provides dividends to shareholders for good performance and penalties for bad; and access to a pool of resources from which a large sum could be drawn and spent immediately to begin capturing all of the benefits of pipeline repair right away, such as Senator Markey's proposed low-interest State Revolving Fund loan.

Conclusion

It is critical to have U.S. energy infrastructure and resources serve its customers at the local, regional, national, and global climate scale, so as not lead to great sacrifices in safety, security, and quality of life at home and abroad at the profit of shareholders and the expense of ratepayers and consumers. Reducing the leakage of natural gas from old pipes and infrastructure in states like Massachusetts that are highly dependent upon natural gas and

whose infrastructure is no longer adequate is not an option but, rather, an imperative. The cost of repair and mitigation will be significant; estimated here to be as much or more than \$720 million. The recommendations presented here provide a pathway to begin the modernization of the state's natural gas infrastructure that will protect ratepayers, incentivize gas companies, and make Massachusetts safer and more sustainable.

Limitations & Questions for Further Research

Some limitations to the research project include that the case study subjects have changed “behaviors” recently enough so as to make quantifying outcomes difficult or impossible. This is especially so because reporting, often self-reporting, occurs within multiple state and federal agencies, and is rarely observable without those agencies acting as conduits of information, and which often present a time delay.

A question for further research might be to test, through modeling or observation, whether or not more accurate or standardized calculations of LAUF gas correlates with reducing the loss, and with reducing leaks, specifically. A further question is one that is currently being examined, and is: what part does distribution system leaks and loss play in the life cycle analysis of the true carbon costs and environmental impacts of using natural gas as a fuel for the U.S.?

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Appendices

Appendix A

Natural Gas Leaks Reduction Strategy Questions

1. What is the organization for which you work, and what is your role?
2. How do your organization and your position interact with natural gas distribution activities?
3. Do you believe that there is a problem with the rate of leakage or of lost and unaccounted for gas in this system?
4. For approximately how long have you held the belief that there is or is not a problem with these rates?
5. Do you have a professional role in working towards reducing fugitive gas emissions? If so, please describe that role and its origin and motivation.
6. Do you believe that current approaches to limiting gas loss via the distribution system with which you are familiar are sufficient?
 - a. Can you give, or point me to, an accounting of the success of these approaches, quantitatively or qualitatively? (For example, percent reduction of fugitive emissions or reduction in total.)
 - b. What, in your opinion or estimation, might be weaknesses or shortcomings of the approach?
7. Have you heard of or observed systems other than yours which you believe to be doing an effective job of limiting, or working to limit, gas leaks from their distribution system?
 - a. If so, please explain your observations.
 - b. Might these approaches be duplicated or mimicked in whole or in part in other systems to help achieve reductions in gas loss?
8. My goal is to seek out and understand best practices for reducing gas leaks from distribution systems, and to draft recommendations for Massachusetts to further reduce our lost and unaccounted for rates. What other questions should I be asking, in your opinion? Whom else should I request to speak with, or what written materials do you recommend I include in my analysis?

Informed Consent for Research Participation

Research Topic: Policy Options for Reducing Natural Gas Leaks in Massachusetts

Dear _____,

My name is Becky Smith. I am a graduate student at Duke University. I am conducting research on what measures are being taken in and around Massachusetts to reduce fugitive natural gas emissions from distribution systems, and what best practices might be drawn on from other systems to help further reduce the rate of lost and unaccounted for gas in Massachusetts.

You are being asked to participate in this study to help me better understand what efforts are currently being made from where you and/or your organization operate in relation to natural gas distribution to measure and/or reduce lost and unaccounted for gas levels from your distribution infrastructure. This study involves answering a few questions, which I estimate will take about 30 minutes of your time. Your responses to the interview questions will be used in a research paper that is a requirement to complete a Master's Degree in Environmental Management at Duke University.

It is completely up to you to participate in this study, and you may withdraw at any time and skip any question you prefer not to answer. I do not anticipate any risks to you as a participant. I would like to identify you by name and attribute quotations to you in my final research paper, though you certainly have the option to have your identity kept confidential. If you wish to keep your participation in this study confidential, please indicate by checking the box at the bottom of this Informed Consent Form and I will not include your name or any information that could identify you in my report. If you permit me to audio-record our conversation, I will use it simply to help me capture accurate notes, and then I will delete the recording when I finish my paper. Please feel free to ask any questions about me, my research or the interview at any time. You can reach me at the following:

Becky Smith

Duke Environmental Leadership, Masters of Environmental Management, Candidate for 2014

617.314.2347

c.rebecca.smith@duke.edu

Duke University faculty advisor for this portion of my research is Deborah Gallagher, PhD. She may be reached at deb.gallagher@duke.edu.

If you have any questions about your rights as a participant in this research, please contact the Duke University Institutional Review Board at ors-info@duke.edu or 919-684-3030.

Participant Signature _____ Date _____

Printed Name of Participant _____

☐

I would like to identify you by name and attribute quotations to you in my final research paper. Check here if you wish to keep your identifying information confidential.

**Please keep a copy of this consent form for your personal records.*

Appendix B

Sample of email interview response

Natural Gas Leaks Reduction Strategy Questions

1. What is the organization for which you work, and what is your role?
 - a. I work for the Pennsylvania Public Utility Commission (PaPUC) and am a Management Efficiency Review Supervisor.
2. How do your organization and your position interact with natural gas distribution activities?
 - a. There are multiple areas where the PaPUC interact with natural gas distribution companies (NGDCs). These activities are highlighted in the Proposed Rulemaking Order at Docket No. L-2012-2294746 at pgs. 4-6 and in *Unaccounted-for-Gas in the Commonwealth of Pennsylvania* attached to the Proposed Rulemaking Order at pgs 3-10.
3. Do you believe that there is a problem with the rate of leakage or of lost and unaccounted for gas in this system?
 - a. As mentioned in the Proposed Rulemaking Order, leakage is a component of unaccounted for gas (UFG) and provided justification for the Final Rulemaking Order. In addition, PaPUC has taken issue with the amount of leaks/breaks on a system in other proceedings such as Focused Management and Operations Audit of UGI Utilities, Inc., UGI Centreal Penn Gas, Inc. and UGI Penn Natural Gas, Inc. at Docket Nos. D-2011-2221061, 2221062, and 2221063; Finding and Conclusion No. VII-3 pgs. 50-53 and Focused Management and Operations Audit of T.W. Phillips Gas and Oil Co at Docket No. D-07MGT022; Finding and Conclusion No. VII-2 pgs. 45-50.
4. For approximately how long have you held the belief that there is or is not a problem with these rates?
 - a. UFG levels, main breaks, etc. have been part of PaPUC's activities for some time now as referenced in the Proposed Rulemaking Order.
5. Do you have a professional role in working towards reducing fugitive gas emissions? If so, please describe that role and its origin and motivation.
 - a. The Bureau of Audits performs management audits on gas utilities with \$10 million in plant or more. As such, my team would investigate all aspects of a utilities operation (including main breaks, UFG levels, etc.) and generate findings and recommendations in a public report.
6. Do you believe that current approaches to limiting gas loss via the distribution system with which you are familiar are sufficient?
 - a. At the April 4, 2013 Public Meeting, the PaPUC adopted its final rulemaking Order regarding unaccounted-for-gas (UFG). Rulemaking Re: Establishing a Uniform Definition and Metrics for Unaccounted-for-Gas, Docket No. L-2012-2294746 (2013), codified at 52 Pa. Code Chapter 59. After regulatory review and approval, the Commission published

the Final Rulemaking in the Pennsylvania Bulletin on August 10, 2013. 43 PA.B. 4586.
The regulations are now in effect.

7. Can you give, or point me to, an accounting of the success of these approaches, quantitatively or qualitatively? (For example, percent reduction of fugitive emissions or reduction in total.)
 - a. As the Final Rulemaking Order became effective in August 2013 and had a one year grace period, the PaPUC has not recorded any results of the Final Rulemaking Order.
8. What, in your opinion or estimation, might be weaknesses or shortcomings of the approach?
 - a. Not applicable
9. Have you heard of or observed systems other than yours which you believe to be doing an effective job of limiting, or working to limit, gas leaks from their distribution system?
 - i. *Gas leaks are the result of various activities/programs by a natural gas utility as mentioned on page 11 of the Unaccounted-for-Gas in the Commonwealth of Pennsylvania attached to the Proposed Rulemaking.*
 - b. If so, please explain your observations.
 - c. Might these approaches be duplicated or mimicked in whole or in part in other systems to help achieve reductions in gas loss?
 - i. See the Final Rulemaking Order for some discussion on this concept, particularly pgs. 11-19.
10. My goal is to seek out and understand best practices for reducing gas leaks from distribution systems, and to draft recommendations for Massachusetts to further reduce our lost and unaccounted for rates. What other questions should I be asking, in your opinion? Whom else should I request to speak with, or what written materials do you recommend I include in my analysis?

Appendix C

Massachusetts Gas Leaks Bill: Senate Bill 2073

SENATE No. 2073

The Commonwealth of Massachusetts

In the Year Two Thousand Fourteen

SECTION 1. Section 105A of chapter 164 of the General Laws, as appearing in the 2012 Official Edition, is hereby amended by striking out the second paragraph and inserting in place thereof the following paragraph:-

Any person, firm or corporation who violates any provision of any code adopted by the department pertaining to the safety of pipeline facilities and the transportation of gas, or any regulation or rule thereunder, at a time when the department has submitted and has in effect the annual certification to the United States Secretary of Transportation provided for in 49 U.S.C. § 60105 shall be subject to civil penalties as specified in 49 U.S.C. § 60122(a)(1) or any successor statute enacted into federal law for the same purposes as said § 60122(a)(1).

SECTION 2. Said chapter 164 of the General Laws is hereby further amended by adding the following 2 sections:-

Section 144. (a) There shall be uniform natural gas leak classification standards in the commonwealth for all natural gas companies.

(b) Gas companies shall access a grade to all reported gas leaks based on the following system:

(1) Grade 1. A leak that represents an existing or probable hazard to persons or property. Grade 1 leaks require repair and continuous action until the conditions are no longer hazardous. The gas company shall immediately schedule a completion of repairs and the condition shall be kept under continuous surveillance until the hazard or source of the leak is eliminated. A gas company shall immediately notify the fire department and chief law enforcement officer in each city or town where a Grade 1 leak is identified.

(2) Grade 2. A leak that is recognized as non-hazardous to persons or property at the time of detection, but justifies scheduled repair based on probable future hazard. Grade 2 leaks The gas company shall be repair or clear Grade 2 leaks within 12 months from the date the leak was classified. All Grade 2 leaks shall be reevaluated by a gas company at least once every 6 months until eliminated; provided, however, that the frequency of reevaluation shall be

determined by the location and magnitude of the leakage condition.

(3) Grade 3. A leak that is recognized as non-hazardous to persons or property at the time of detection and can be reasonably expected to remain non-hazardous. The gas company shall reevaluate Grade 3 leaks during the next scheduled survey, or within 12 months from the date last evaluated, whichever occurs first, until the leak is eliminated or the main is replaced. A municipal or state public safety official may request a reevaluation of a Grade 3 leak prior to the next scheduled survey, or sooner than 12 months of the date last evaluated, if the official reasonably believes the Grade 3 leak poses a threat to public safety.

(c) Upon the undertaking of a significant project involving the repair or paving of a public way exposing confirmed natural gas infrastructure, a municipality or the commonwealth shall submit written notification of the project to a gas company. The gas company shall survey the project area for the presence of Grade 1 or Grade 2 leaks and set repair and replacement schedules for any known or newly detected Grade 1 or Grade 2 leaks. The gas company shall ensure that any shut off valve in the project area has a gate box installed upon it and that the shut off valve is operational and accessible. A gas company may repair any known or newly detected Grade 3 leaks at its discretion or after consultation with the municipality or the commonwealth. The repair and replacement schedule of Grade 1 and Grade 2 leaks shall be provided to the municipality or the commonwealth and shall include a notification of the presence of any Grade 3 leaks that were detected during the survey.

(d) Gas companies shall prioritize any pipeline repairs required under this section for gas leaks detected within a school zone. For the purposes of this section, the term “school zone” shall mean on or within 50 feet of the real property comprising a public or private accredited preschool, accredited Head Start facility, elementary, vocational or secondary school.

(e) As part of the annual service quality standards report required by section 1I, each gas company shall report to the department the location of each Grade 1, Grade 2 and Grade 3 leak existing as of the date of the report, the date each Grade 1, Grade 2 and Grade 3 leak was classified and the dates of repairs performed on each Grade 1, Grade 2 and Grade 3 leak. A gas company shall specify any reclassification of previously identified leaks in its annual report. Gas leak information shall be made available to any municipal or state public safety official upon written request.

(f) The department shall promulgate regulations necessary to implement the uniform natural gas leak classification standards as specified in this section and shall oversee and monitor company response and reporting; provided, however, that the regulations shall prevent a gas company from downgrading a Grade 1 or Grade 2 leak unless the leak is repaired.

Section 145. (a) For the purposes of this section, the following words shall, unless context clearly requires otherwise, have the following meanings:-

“Customer”, a retail natural gas customer.

“Eligible infrastructure replacement”, a replacement or an improvement of existing

infrastructure of a gas company that: (i) is made on or after January 1, 2015; (ii) is designed to improve public safety or infrastructure reliability; (iii) does not increase the revenue of a gas company by connecting an improvement for a principal purpose of serving new customers; (iv) reduces, or has the potential to reduce, lost and unaccounted for natural gas losses through a reduction in natural gas system leaks; and (v) is not included in the current rate base of the gas company as determined in the gas company's most recent rate proceeding or is not included in any other targeted infrastructure replacement program previously approved by the department.

"Plan", a targeted infrastructure replacement program construction plan that a gas company files under subsection (b).

"Project", an eligible infrastructure replacement project proposed by a gas company in a plan filed under this section.

(b) A gas company may file with the department a targeted infrastructure replacement program construction plan to address aging or leaking natural gas infrastructure within the commonwealth in the interest of public safety and reducing lost and unaccounted for gas through a reduction in natural gas system leaks.

(c) Any plan filed with the department shall include, but not be limited to: (i) eligible infrastructure replacement of mains, services, meter sets and other ancillary facilities composed of non-cathodically protected steel, cast iron and wrought iron, prioritized to implement the federal gas distribution pipeline integrity management plan annually submitted to the department and consistent with subpart P of 49 C.F.R. part 192; (ii) an anticipated timeline for the completion of each project; (iii) the estimated cost of each project; (iv) rate change requests; (v) a description of customer costs and benefits under the plan; and (vi) any other information the department considers necessary to evaluate the plan.

(d) Provided that a gas company files a plan on or before October 31 for the subsequent construction year, the department shall review the plan within 6 months. The plan shall be effective as of the date of filing, pending department review. The department may modify a plan prior to approval at the request of a gas company or make other modifications to a plan as a condition for approval. The department shall consider the costs and benefits of the plan, including, but not limited to, impacts on ratepayers, reductions of lost and unaccounted for gas through a reduction in natural gas system leaks and improvements to public safety. The department shall give priority to plans narrowly tailored to addressing leak-prone infrastructure most immediately in need of replacement.

(e) If a plan is in compliance with this section and the department determines the plan to reasonably accelerate eligible infrastructure replacement and provide benefits, the department shall issue preliminary acceptance of the plan, in whole or in part. A gas company shall then be permitted to begin recovery of the estimated costs of projects included in the plan beginning on May 1 of the year following the initial filing and collect any revenue requirement, including depreciation, property taxes and return associated with the plan.

(f) On or before May 1 of each year, a gas company shall file final project

documentation to demonstrate substantial compliance with the plan approved under subsection (e) and that project costs were reasonably and prudently incurred. The department shall investigate project costs within 6 months of submission and shall approve and reconcile the authorized rate factor, if necessary, upon a determination that the costs were reasonable and prudent. Annual changes in the revenue requirement eligible for recovery shall not exceed 1.5 per cent of the gas company's most recent calendar year total firm revenues, including gas revenues attributable to sales and transportation customers. Any revenue requirement approved by the department in excess of the 1.5 per cent total firm revenue cap may be deferred for recovery in the following year.

(g) All rate change requests made to the department pursuant to an approved plan shall be filed annually on a fully reconciling basis. A gas company shall file reconciliation adjustment rates, which shall be subject to investigation by the department under subsection (f) to determine whether the company has over-collected or under-collected its requested rate adjustment. The reconciliation adjustment rates shall become effective pursuant to department order pending the investigation pursuant to said subsection (f). If the department determines that any of the costs were not reasonably or prudently incurred, or were not in compliance with the approved plan, the department shall disallow the costs and shall direct the gas company to refund the full value of the costs charged to customers in the next reconciliation filing with the appropriate carrying charges on the over-collected amounts.

(h) The department shall promulgate rules and regulations under this section, which shall include a procedure that discontinues the replacement program and allows a gas company to refund any costs charged to customers due to failure to substantially comply with a plan or failure to reasonably and prudently manage project costs.

SECTION 3. On or before January 1, 2015, the department of public utilities shall authorize gas companies to design and offer programs to customers which increase the availability, affordability and feasibility of natural gas service for new customers.

(a) As part of the department's approval of a program and prior to implementation of a program, the department shall: (i) review each gas company's determination that a main or service extension is economically feasible; (ii) review each gas company's contribution in aid of construction policy and methodology; and (iii) consider alternative rate mechanisms or company project review methodology that facilitate access to natural gas service for new customers, including, but not limited to, (1) new service-territory-wide surcharges to aid in the financing of gas service expansion to new off-main customers; (2) new area surcharges applicable only to zones of new off-main customers to aid in the financing of gas service expansion to new off-main customers; or (3) both; provided, however, that natural gas distribution system expansion surcharges shall not unreasonably burden existing customers. Guidelines established under this subsection shall outline the department's methods and procedures for reviewing proposals, including factors the department shall consider for program or policy approval.

(b) Gas companies may petition the department independently, or in coordination with the department of energy resources, to approve: (i) financing programs for customer natural gas conversion costs repaid on participating customer bills; (ii) other financing programs developed

by a gas company; or (iii) other cost effective programs that reasonably accelerate the expansion of and conversion to natural gas usage in the commonwealth; provided, however, that the programs do not unreasonably burden existing natural gas customers.

(c) The department shall issue a decision on gas company expansion programs filed with the department pursuant to this section within 8 months of the filing date. Gas companies shall file appropriate tariff changes and otherwise implement any gas expansion programs or policies approved under this section.

(d) The department shall consider programs that are likely to accelerate the conversion or expansion to natural gas usage for low-income consumers currently eligible for the federal Low Income Home Energy Assistance Program, 42 U.S.C. § 8621 et seq., including programs that exempt new residential low-income heating customers from any new area surcharge developed under this section. Notwithstanding subsection (b), the department may approve alternative methods of cost recovery by a gas company for low-income programs, policies or exemptions including impacts on uncollectible costs.

SECTION 4. Notwithstanding any general or special law to the contrary, the department of public utilities shall open an investigation into gas operator compliance with the directives set forth in its Order D.T.E.\D.P.U. 06-48-A. The department shall complete its investigation and submit its findings to the clerks of the house of representatives and the senate and the house and senate chairs of the joint committee on telecommunications, utilities and energy not later than June 1, 2015.

SECTION 5. Notwithstanding any general or special law to the contrary, the department of public utilities shall, after determination by a gas company or a local or state public safety official that a gas leak has caused an explosion, issue written findings as to why an investigation is or is not necessary to determine the cause of the explosion.

SECTION 6. Notwithstanding any general or special law to the contrary, the secretary of public safety and security or a designee shall issue a report on the adequacy of state regulations governing the safety standards for utility transformer vaults located within buildings subject to the state building code. The report shall include, but not necessarily be limited to, an analysis of the standards for access, structural integrity, ventilation and lighting requirements of the regulations and the inspection and enforcement requirements, if any, of the regulations. The report shall further address structural limitations of older buildings containing utility transformer vaults, any ancillary costs, including the cost of inspections and possible costs to businesses and municipalities to comply with any proposed new regulations, and any recommendations for legislation necessary to further implement minimum safety standards for utility transformer vaults. The report, together with any proposed regulations or legislation necessary to carry out the recommendations, shall be submitted to the clerks of the house of representatives and the senate not later than November 15, 2014.

SECTION 7. The department shall investigate whether it should require the winter surveillance and patrol of cast iron gas pipelines in the commonwealth and shall determine whether the presence of extended frost cap conditions may result in additional stress on cast iron

pipe segments, requiring enhanced surveillance and patrol. The department may establish minimum uniform procedures for cast iron winter surveillance and patrols consistent with any federally mandated standards for integrity management programs for distribution pipelines. Gas companies may establish procedures that exceed any minimum standards, subject to applicable filing requirements with the department.

SECTION 8. Section 145 of chapter 164 of the General Laws shall take effect on October 1, 2014.

Appendix D

Pennsylvania's Regulation

ANNEX A

TITLE 52. PUBLIC UTILITIES

PART I. PUBLIC UTILITY COMMISSION

Subpart C. FIXED SERVICE UTILITIES

CHAPTER 59. GAS SERVICE

UNACCOUNTED-FOR-GAS

§ 59.111. Unaccounted-for-gas.

- (a) *Definitions.* The following words and terms, when used in this section, have the following meanings, unless the text clearly indicates otherwise:

Adjustments- Gas used by an NGDC or city natural gas distribution operation for safe and reliable service, such as company use, calculable losses from construction, purging, STORAGE MIGRATION, other temperature and pressure adjustments, and adjustments for heat content of natural gas. ~~Adjustments must be supported by metered data, sound engineering practices, or other quantifiable results that clearly support the utility's need for the adjustment. Adjustments must be consistent from filing to filing.~~

Gas delivered- Gas provided by the distribution, transmission, storage or production/gathering facilities of an NGDC or city natural gas distribution

operation, regardless of use, adjusted for any temperature or pressure variations. This category includes quantities of gas consumed by an end user, exchange gas supplied to another utility, gas delivered to transportation customers or other gas delivered to a user other than the utility. When bill timing issues arise, an effort shall be made to reasonably estimate consumption.

Gas received - Gas that is supplied to the distribution, transmission, storage, or production/gathering facilities of an NGDC or city natural gas distribution operation, regardless of use, adjusted for any temperature or pressure variations. This category includes gas for sales, storage, transportation quantities, exchange gas received or other quantity of gas that otherwise enters the utility's facilities.

NGDC-Natural gas distribution company.

~~*UFG-Unaccounted-for-gas* - The calculation for gas lost by the system, including gas lost due to breaks, leaks, theft of service, unmetered consumption, meter inaccuracies, or other point of lost, unidentifiable, or non-revenue producing gas.~~
THE DIFFERENCE BETWEEN THE TOTAL GAS AVAILABLE FROM ALL SOURCES AND THE TOTAL GAS ACCOUNTED FOR AS SALES, NET INTERCHANGE AND COMPANY USE. THIS DIFFERENCE INCLUDES LEAKAGE OR OTHER ACTUAL LOSSES, DISCREPANCIES DUE TO METER INACCURACIES, VARIATIONS OF TEMPERATURES OR PRESSURES OR BOTH, AND OTHER VARIANTS, PARTICULARLY BILLING LAG.

(b) *Calculation.*

$$(1) \text{UFG}_x = \text{Gas Received}_x - \text{Gas Delivered}_x - \text{Adjustments}_x$$

$$(2) \% \text{UFG}_x = (\text{UFG}_x) / (\text{Gas Received}) * 100$$

- (3) X denotes the system type (distribution, transmission, storage, or production/gathering). When possible, UFG must be computed and reported by system type.
- (4) Gas received, gas delivered and adjustments must represent actual gas quantities. Estimates may be provided but must be clearly identified and have supporting justification, assumptions and calculations.
- (5) Adjustments must be individually identified by category (~~that is,~~ SUCH AS company use, calculable losses from construction, purging, STORAGE MIGRATION, other temperature and pressure adjustments, and adjustments for heat content of natural gas). ADJUSTMENTS MUST BE SUPPORTED BY METERED DATA, SOUND ENGINEERING PRACTICES OR OTHER QUANTIFIABLE RESULTS THAT CLEARLY SUPPORT THE UTILITY'S NEED FOR THE ADJUSTMENT. ADJUSTMENTS MUST BE CONSISTENT FROM FILING TO FILING.
- (6) The definition of UFG in subsection (a) and the calculation under this subsection apply to UFG filed with the Commission.

(c) *Metrics for distribution system losses.*

- (1) Each NGDC and city natural gas distribution operation shall, at a minimum, reduce distribution system loss performance in accordance with the metrics in the following table, beginning with its first subsequent PGC or GCR filing after ____ (Editor's Note: The blank refers to 1 year after the effective date of adoption of this proposed rulemaking.). The metric starts with 5% in the first year and decreases by 0.5% every year in the subsequent years until it reaches 3% as shown in the following table:

Year Percent UFG

1	5.00%
2	4.50%
3	4.00%
4	3.50%
5	3.00%

- (2) The distribution metrics shall be applied on an annual basis for the 12 MONTHS ~~year ending December~~ AUGUST 31. UFG REPORTS, AS DESCRIBED BY THE COMMISSION AND RELATING TO THIS SECTION, SHALL BE FILED NO LATER THAN SEPTEMBER 30th OF EACH YEAR.
- (3) UNACCOUNTED-FOR-GAS LEVELS ABOVE THE APPLICABLE ANNUAL TARGETS SET FORTH IN SECTION 52.111(C)(1) SHALL BE PRESUMED TO BE EXCESSIVE ABSENT EVIDENCE TO THE CONTRARY AND ~~Amounts of UFG in excess of the standard~~ may not be recovered within the current or a future PGC or GCR filing ~~unless approved by the Commission~~. IF AN NGDC'S ACTUAL UFG EXCEEDS AN APPLICABLE TARGET, THE NGDC MAY DEMONSTRATE THAT ITS LEVEL OF UFG IS WARRANTED.

Appendix A

Reporting Unaccounted-For-Gas

Distribution System

Specify units for quantity of gas

X

A. Gas Received

From Production Facilities X

From Transmission Facilities X

From Storage Facilities X

From Interstate Pipelines directly into the Distribution System X

From Other Sources (i.e., propane injections, etc.) X

Total Gas Received by the Distribution System X

B. Gas Delivered

To Customers (i.e., Transportation Residential, Commercial, Industrial, etc.) X

To Storage X

To Transmission System X

Total Gas Delivered by the Distribution System X

C. Adjustment Examples

Pressure/Temperature Adjustments X

Located & Repaired Breaks in Mains & Services	X
Company use	X
Purging/Other Construction activities	X
Heat Content	X
Meter Read Cycle Adjustments	X
Other	X
Total Adjustments	X
D. Distribution UFG	
Total	A-B-C
E. Percent UFG	
Percentage	$(D/A)*100\%$

Note: Additional categories can be added in sections A, B and C. However, a brief explanation of the added field is needed.

Transmission System Losses

Specify units for quantity of gas X

A. Gas Received	
From Interstate Pipelines	X
From Storage	X
From Distribution System	X
From Production/Gathering System	X
From Other	X

Total Gas Received by the Transmission System	X
B. Gas Delivered	
To Distribution System	X
To Customers/sold	X
To Interstate Pipeline	X
To Storage	
Total Gas Delivered by the Transmission System	X
C. Adjustment Examples	
Pressure/Temperature Adjustments	X
Located & Repaired Breaks in Mains & Services	X
Company use	X
Purging/Other Construction activities	X
Heat Content	X
Meter Read Cycle Adjustments	X
Other	X
Total Adjustments	X

D. Production Facility UFG

Total

A-B-C

E. Percent UFG

Percentage

 $(D/A)*100\%$

Note: Additional categories can be added in sections A,B and C. However, a brief explanation of the added field is needed.

Storage System

Specify units for quantity of gas

X

A. Gas Received

From Production Facilities

X

From Transmission Facilities

X

From Distribution Facilities

X

From Interstate Pipelines directly into the Distribution System

X

Total Gas Received by the Storage System

X

B. Gas Delivered

To Transmission System

X

To Distribution System

X

To other facilities

X

Sold	X
Total Gas Delivered by the Storage System	X
C. Adjustment Examples	
Company use	X
Storage Migration (+/-)	X
Heat Content	X
Located & Repaired Breaks	X
Other	X
Total Adjustments	X
D. Storage UFG	
Total	A-B-C
E. Percent UFG	
Percentage	$(D/A) \times 100\%$

Note: Additional categories can be added in sections A,B and C. However, a brief explanation of the added field is needed.

Production/Gathering System Losses

Specify units for quantity of gas

X

A. Gas Received

From Production Wells

X

From Other Gathering Systems

X

Total Gas Received by the Production/Gathering System

X

B. Gas Delivered

To Distribution System

X

To Customers/sold

X

To Transmission System

X

Total Gas Delivered by the Production/Gathering System

X

C. Adjustment Examples

Pressure/Temperature Adjustments

X

Located & Repaired Breaks in Mains & Services

X

Company use

X

Purging/Other Construction activities

X

Heat Content

X

Meter Read Cycle Adjustments

X

Other	X
Total Adjustments	X
D. Production Facility UFG	
Total	A-B-C
E. Percent UFG	
Percentage	$(D/A)*100\%$

Note: Additional categories can be added in sections A,B and C. However, a brief explanation of the added field is needed.

Appendix E

Massachusetts Department of Public Utilities' Current (2014) Study Description & Request for Quotes

Reduce Emissions from the Natural Gas Distribution Network

Methane is the main component of natural gas. Methane is a powerful greenhouse gas (GHG), over 20 times stronger than the most common GHG, carbon dioxide. Methane leaks from gas pipeline/transmission networks, gas distribution networks, and natural gas storage.

The Massachusetts Department of Energy Resources (DOER) is working with Sussex Economics Advisors on a review of natural gas distribution expansion, including a task to determine the CO₂ reduction from converting heating from oil to natural gas. In addition, the Massachusetts Department of Public Utilities (DPU) awarded a 9-month contract (with the possibility of a 6-month extension) to ICF in October 2013, to assist DPU in helping to quantify the amount of natural gas that is lost or unaccounted for, either intentionally or unintentionally, during distribution, in order to review and potentially identify methods and procedures to reduce methane emissions.

The results of these two studies, in concert with other DOER work on the potential to use renewable thermal energy in Massachusetts, will assist the Commonwealth in understanding the interaction between renewable thermal use, possible natural gas system expansion and methane leakage from natural gas distribution pipelines.

July 30, 2013
REQUEST FOR QUOTES
Department of Public Utilities
Procurement Department
One South Station
Boston, Massachusetts 02110
Telephone: (617) 305-3500

1. General

1.1 Overview

Through this Request for Quote ("RFQ") the Massachusetts Department of Public Utilities ("DPU") invites proposals from qualified consulting firms ("Consultant") on state contract PRF46 to assist the DPU in helping to quantify the amount of natural gas that is lost or unaccounted for, either intentionally or unintentionally, during distribution, in order to review and potentially identify methods and procedures to reduce methane emissions. Methane is the main component of natural gas and is a much more powerful greenhouse gas ("GHG") than the most common GHG, carbon dioxide, and, therefore, a very significant contributor to climate change.

1.2 Background

Lost and unaccounted for natural gas is the difference between the amount of gas bought by a local distribution company ("LDC") and the amount of gas it sells. Unaccounted for gas is a significant factor contributing to GHG emissions. Thus, the Environmental Protection Agency (EPA) has established regulations requiring that oil and gas industries report GHG emissions. Specifically, the EPA's regulations established emission factors for distribution pipelines, which the DPU regulates. See 40 C.F.R. Part 98, Subpart W. Distribution systems with large amounts of leak-prone pipe are more likely to emit larger amounts of emissions. Cast iron and unprotected steel are categorized as leak-prone pipe since emissions from this pipe are greater than from cathodically protected steel and plastic pipe. In Massachusetts at year end of 2012, approximately 6,600 miles of leak-prone pipe was still in use, which comprises approximately 31% of the distribution system. Currently, there is no reliable method for calculating the amount of lost and unaccounted for natural gas that escapes from distribution pipelines. This makes it extremely difficult to evaluate the magnitude of the environmental impacts of methane emissions.

1.3 Procurement Scope and Description

The Consultant will be responsible for reviewing reporting requirements of the LDCs, pursuant to applicable state and federal pipeline statutes and policies of the Pipeline and Hazardous Materials Safety Administration ("PHMSA") and the DPU. This will include assessing the most

efficient way for the LDCs to obtain and provide to the DPU accurate records pertaining to their gas distribution systems and operations. The goal is to determine if the LDCs' records and corresponding reporting procedures are adequate to support accurate reporting of unaccounted for gas loss.

Specific responsibilities may include:

☐ Conducting a mass balance analysis of the fate of gas entering Massachusetts gas distribution systems in a recent year, through its¹:

¹ Many of these leak categories are from the US EPA GHG Reporting Rule at 40 CFR Part 98 Subpart W, Tables W-5 and W-7, see <http://www.gpo.gov/fdsys/pkg/CFR-2012-title40-vol22/pdf/CFR-2012-title40-vol22-part98-subpartW.pdf>.

- use by customers (including a range accounting for meter inaccuracy),
 - use by distribution companies (including a range accounting for meter inaccuracy),
 - theft,
 - venting due to maintenance,
 - venting from storage tanks,
 - venting due to other causes,
 - leaks from liquefied natural gas (LNG) storage valves,
 - leaks from LNG storage pump seals,
 - leaks from LNG storage connectors,
 - leaks from LNG storage equipment other than connectors, pump or valves,
 - leaks from LNG storage compressors,
 - leaks from connectors,
 - leaks from block valves,
 - leaks from control valves,
 - leaks from pressure release valves,
 - leaks from orifice meters,
 - leaks from regulators,
 - leaks from open-ended lines,
 - leaks from below grade metering stations (by inlet pressure >3000 psig, 100-300 psig and <100 psig),
 - leaks from distribution mains (by unprotected steel, protected steel, plastic and cast iron), and
 - leaks from distribution services (by unprotected steel, protected steel, plastic and cast iron).
- ☐ Recommending methods to increase the accuracy of the reporting of methane emissions from the natural gas infrastructure by the local gas distribution companies;
- ☐ Identifying a reliable method for calculating the amount of lost and unaccounted for natural gas that escapes from distribution pipelines;

- ☐ Recommending policies to promote the reduction of methane emissions and reduce the costs of lost and unaccounted for gas;
- ☐ meeting with DPU Commissioners, staff, LDCs, and others, as necessary or as directed by the DPU;
- ☐ identifying and preparing preliminary recommendations for possible changes in the manner in which the DPU obtains information from LDCs;
- ☐ identifying and preparing preliminary recommendations for possible changes in reporting practices and procedures;
- ☐ submitting a final report and presenting the findings to the DPU.

1.4 Number of Awards

It is anticipated that the DPU will award a single contract (“Contract”) with a Consultant pursuant to this RFQ. However, the DPU may award additional contracts if it deems that it is in the best interest of the Commonwealth to do so. The DPU will evaluate responses to the RFQ based on the points achieved relating to the established evaluation criteria, described below. The DPU will award the contract to the bidder with the highest score. If the bidder with the highest score does not execute the contract, then the DPU may award a contract to the bidder with the next highest score, until a qualified Consultant has been retained and is under contract. The evaluation criteria will be based on what constitutes the best value for the Commonwealth.

1.5 Acquisition Method

The acquisition method to acquire services from this Solicitation is fee for service. Fee for service means that the winning Bidder is not guaranteed a fixed payment amount, but rather will bill the DPU on a monthly basis for hours worked and other eligible expenses. The DPU may require prior approval of hours to be worked during certain time periods.

1.6 Contract Duration

The expected duration of the Contract is estimated to be nine months, commencing upon the execution of the Contract. In addition, the DPU has the option to extend this Contract for six additional months, if necessary, for services covered by and/or related to the scope of work contained within this RFQ.

1.7 Estimated Value of Contract

The estimated value of the total Contract is \$250,000. The Commonwealth makes no guarantee that any commodities or services will be purchased from any Contract resulting from this Solicitation. Bidders’ responses will be evaluated on cost effectiveness and best value for the Commonwealth, among other criteria.

2. Estimated Procurement Calendar

Solicitation Deadline: 4:00 pm on Friday August 10, 2013. The DPU anticipates selecting a Consultant after the evaluation and qualifying process.

3. Specifications

3.1 Bidder Qualifications – General experience and expertise of selected PRF46 vendor. The DPU requires the services of a Consultant experienced in natural gas pipeline systems, federal gas pipeline safety requirements, and state and federal regulatory requirements for LDCs. Bidders should also demonstrate their experience with, and knowledge of, the following areas:

- ☐ Natural gas pipeline distribution system engineering, operations, reporting, maintenance and management;
 - ☐ Liquefied natural gas plant operation and maintenance;
 - ☐ State and federal regulatory requirements applicable to pipeline safety; and
- Bidders should also have outstanding oral and written communication skills.

3.2 Service Specifications

The Consultant will work on-site at the DPU as required, as directed by the DPU, and as reflected in an agreed-upon schedule. Occasional night or weekend work may be required. The Consultant will work under the supervision of the DPU's Director of Pipeline Engineering and Safety.

3.3 Environmental Specifications

Environmental Purchasing Policy: Per Executive Order 515, issued October 27, 2009, Executive Departments are required to reduce their impact on the environment and enhance public health by procuring environmentally preferable product and services (EPPs) whenever such product and services perform to satisfactory standards and represent best value. EPPs are considered to be products and services that help to conserve natural resources, reduce waste, protect public health and the environment, and promote the use of clean technologies, recycled materials and less toxic products.

3.5 Compensation structure

The winning bidder will submit monthly invoices with verification that goods and/or services have been received.

4.0 Confidentiality

The Consultant shall not divulge to third parties any confidential information obtained by the Consultant or its agents, distributors, resellers, subcontractors, officers or employees in the course of performing Contract work, including, but not limited to, security procedures, business operations information, personally identifiable information, or commercial proprietary information in the possession of the DPU. The Consultant shall not divulge to third parties any internal DPU deliberations.

4.1 Conflicts of Interest

Bidders should explain whether they are presently providing or anticipate that they will soon be providing consulting or other services to a natural gas pipeline owner or operator, gas company or electric company or any other entity on a matter pending before the DPU.

4.2 Failure to perform contractual obligations may result in termination.

4.3 Evaluation Criteria

A. **EXPERIENCE:** In this section, the Bidder must demonstrate its capability to provide the services described in the scope of work as outlined in Number 1.3 of this RFQ. The Bidder shall address the required services within the scope of work, and may address other services that are not specifically required. The Bidder must demonstrate its critical understanding of the work required under this RFQ and its capabilities and experience in performing the required services. The information provided must demonstrate that the Bidder possesses the expertise to deliver quality work products on schedule and within budget. The Bidder must include information on prior projects it considers both representative of its qualifications and project experience relevant to the scope of this RFQ.

Each prior project set forth must include the following basic information so that the DPU may verify the performance of the Bidder: a brief description of the project, the client's full business name, address and telephone number including the name, email address and telephone number of the contact person responsible for the project. The DPU may, as part of its evaluation, contact the person identified, and Bidders are advised that the inability of the DPU to contact this person as a result of the Bidder providing incorrect contact information may result in a lower score. The DPU reserves the right to rely on the information provided by the Bidder in its proposal, and may elect not to seek or consider additional or updated information from the Bidder after the deadline for responses to the RFQ.

B. **PERSONNEL:** The Bidder shall identify each member of the Consultant's intended team and provide resumes and/or biographical information describing each individual's education, work experience and qualifications relevant to the scope of work of this RFQ. The Bidder shall describe the anticipated hours or proportional contributions anticipated of individual members of the consulting team. Substitutions of personnel or significant changes in the distribution of responsibilities among team members presented in the response to the RFQ may be made only with prior written consent of the DPU.

C. **PROJECT UNDERSTANDING AND APPROACH:** Bidders shall describe their understanding of the project, demonstrating familiarity with both the RFQ and the

regulatory context in which it is being procured. Respondents shall present an intended scope of work and general approach and specific tasks intended to successfully complete this engagement.

D. RATES AND TOTAL COST: The Bidder must provide estimated hourly labor rates for proposed personnel and the total cost for providing the requested services, including proposed staffing of tasks.

5.0 Selection Criteria

Responses will be evaluated by a Selection Committee consisting of, or appointed by, the DPU. The Selection Committee will evaluate and rank responses to the RFQ pursuant to the following scoring method, based on a maximum total score of 100 points, and submit the results of this ranking to the DPU for its review and determination of the Contract award:

- ☐ Item III A: Experience [30 points]
- ☐ Item III B: Personnel [15 points]
- ☐ Item III C: Project Understanding/Approach [30 points]
- ☐ Item III D: Rates and Total Cost [25 points]

6.0 Proposal Submission

All bids must be submitted on line through Comm-Pass and received by the DPU no later than 4:00 p.m. on Friday, August 10, 2013.